

This application claims benefit of 60/460,791 filed 4/5/03  
and claims benefit of 60/513,471 filed 10/22/03 Docket No. 52139  
and claims benefit of 60/513,476 filed 10/22/03  
**PREPARATION OF GROUP IVA AND GROUP VIA COMPOUNDS**

### Background of the Invention

The present invention relates to the field of Group IV compounds. In particular, this invention relates to the preparation of Group IV organometallic compounds suitable for use in chemical vapor deposition.

Metal films may be deposited on surfaces, such as non-conductive surfaces, by a variety of means such as chemical vapor deposition ("CVD"), physical vapor deposition ("PVD"), and other epitaxial techniques such as liquid phase epitaxy ("LPE"), molecular beam epitaxy ("MBE"), chemical beam epitaxy ("CBE") and atomic layer deposition ("ALD"). Chemical vapor deposition processes, such as metalorganic chemical vapor deposition ("MOCVD"), deposit a metal layer by decomposing organometallic precursor compounds at elevated temperatures, i.e., above room temperature, either atmospheric pressure or at reduced pressures. A wide variety of metals may be deposited using such CVD or MOCVD processes.

For semiconductor and electronic device applications, these organometallic precursor compounds must be highly pure and be substantially free of detectable levels of both metallic impurities, such as silicon and zinc, as well as oxygenated impurities. Oxygenated impurities are typically present from the solvents used to prepare such organometallic compounds, and are also present from other adventitious sources of moisture or oxygen.

For certain applications where high speed and frequency response of an electronic device is desired, silicon-only devices, e.g. silicon bipolar transistors, have not been competitive. In a heterojunction bipolar transistor ("HBT"), a thin silicon-germanium layer is grown as the base of a bipolar transistor on a silicon wafer. The silicon-germanium HBT has significant advantages in speed, frequency response, and gain when compared to a conventional silicon bipolar transistor. The speed and frequency response of a silicon-germanium HBT are comparable to more expensive gallium-arsenide HBTs.

The higher gain, speeds, and frequency response of silicon-germanium HBTs have been achieved as a result of certain advantages of silicon-germanium not available with pure silicon, for example, narrower band gap and reduced resistivity. Silicon-germanium may be epitaxially grown on a silicon substrate using conventional silicon processing and tools. This technique